

consists of sand or crushed quartz, and in some cases layers of some such oxidising material as polarite or oxidium are used, in addition to sand, as in the Candy filter.

The advantages of this method of filtration seem to be the much more rapid rate at which the water can be passed through the filters, and consequently the much smaller area which they occupy, and the ease and rapidity with which they can be cleaned by mechanical means. This effects a great saving of labour, and also does away with the workmen coming in contact with the filtering medium. As regards efficiency, it would appear that these filters are at least as efficient as ordinary sand filters.

After two very useful chapters on "The Purification of Water by Ozone" and "Water Softening and Household Appliances," two chapters follow on the testing of water. They consist of a discussion of the bacteriological, chemical, and microscopic examination of the raw and filtered waters and the inferences to be drawn from them.

The bacteriological tests suggested, and the methods of applying them are, however, somewhat open to criticism, and need revision in subsequent editions, and the suggestion that these tests should be undertaken by the water managers themselves (unless specially qualified) is also perhaps not of the happiest. To anyone acquainted with the bacteriological and chemical analysis of water, it will be apparent that unless these tests are carried out by skilled operators errors of execution and judgment are likely to crop up. The growing necessity of dealing with impure and polluted sources of supply renders frequent and careful analysis imperative, and the example of the Metropolitan Water Board and some of the Continental and American water undertakers in appointing a staff of qualified analysts might well be followed by other bodies.

As the authors point out, the interpretation of the results of analysis depend largely on local conditions, yet they give a table of the standards of purity required in Britain and America, which, by the way, are not applicable to a very large number of water supplies, and they do not state from what source these standards, in so far as they apply to British supplies, are obtained.

In the remaining chapters, the book deals with problems of distribution, and, in addition to engineering problems, several pages are devoted to the development of such growths as crenothrix in the mains and the action of peaty waters on lead. This latter subject was exhaustively investigated by Dr. Houston about fifteen years ago, on behalf of the Local Government Board, and the authors quote extensively from his work; the two kinds of action, plumbosolvency and erosion, although attributed to different causes, are frequently caused by the same water.

The authors have surely misunderstood Dr. Houston's work when they state (on p. 324) that erosion, which results in the formation of the hydroxide of lead, has probably no consequences obnoxious to the consumer, for they go on to say that the hydroxide scales away and mixes with the current. The section

concludes with a general discussion on public health in relation to water supply, and an account is given of several outbreaks of cholera and typhoid fever, which have been attributed to that cause. It should have been pointed out, however, that in the case of the epidemics at Belfast, mentioned on p. 348, the water supply was completely exonerated by the Health Commission appointed to inquire into the matter.

The arrangement of the book is exceedingly good, the type clear, and the numerous diagrams and photographs make the descriptions of the various appliances very easy to understand. As appendices there are some useful tables of filtration constants and other engineering data, and a concise and well-arranged bibliography of works on water purification.

DENISON B. BYLES.

#### GERMAN AND FRENCH BOOKS ON CRYSTALLOGRAPHY.

- (1) *Lehrbuch der Kristallphysik (mit Ausschluss der Kristalloptik)*. By Prof. W. Voigt. Pp. xxiv+964. (Leipzig and Berlin: B. G. Teubner, 1910.) Price 30 marks.
- (2) *Leçons de Cristallographie*. By G. Friedel. Pp. v+310. (Paris: A. Hermann et Fils, 1911.) Price 10 francs.
- (3) *Die Kristallgruppen nebst ihren Beziehungen zu den Raumgittern*. By Prof. E. Sommerfeldt. Pp. vii+79 (Dresden: T. Steinkopff, 1911.) Price 3 marks.

(1) **T**HIS treatise is based upon the lectures delivered for some years past by Prof. Voigt at the University of Göttingen, and it concentrates also into a single volume of 964 pages the original work in physical crystallography other than optical contributed in numerous memoirs during the course of a long and active career. Prof. Voigt's name is, perhaps, most familiar from his work on the elasticity of crystals and their piezo- and pyro-electrical properties. These branches of physical crystallography are well represented in the book before us, and the only criticisms that suggest themselves are that Prof. Voigt has not given us more experimental details and illustrations of the interesting forms of apparatus employed in the researches, and that British work in this branch of science, especially the thermal expansion and elasticity of crystals, is not referred to. The result of these omissions is that in the first place the book presents a somewhat forbiddingly mathematical aspect, the theoretical and mathematical side vastly predominating and entirely overshadowing the practical experimental side of the subject, and that in the second place a certain narrowness of outlook is inevitable.

Having said so much, however, and remembering that Prof. Voigt's chair is that of theoretical physics, the thorough manner in which the subject is dealt with inside these somewhat narrow lines cannot fail to impress the reader. The most valuable consideration is, moreover, that we have here brought together for us the facts and theories for which hitherto investigators and students have had to search through the numerous original papers of Prof. Voigt. The

specialised portion of the book is preceded by an admirable review of the morphology of crystals and the structure theories of Bravais, Wiener, Sohncke, von Fedorow, and Schönflies (again we notice the omission of a British name, that of Barlow). Such a review is of special value, as it gives us the considered opinion of one who regards crystals essentially from the physical and mechanical point of view, and whose original investigations have brought him more than usually in touch with the phenomena dependent on the internal molecular and atomic arrangement of crystals. The influence of such an experience and of the character of this field of research is evident in a most interesting manner throughout. As Prof. Voigt so truly says:—

“Die besonderer Bedeutung welche die Krystallform für den Aufbau der Krystallphysik besitzt, liegt darin, dass dieselbe eine einfachste und anschaulichste physikalische Wirkung der Konstitution der Substanz darstellt.”

The specialised portion of the book deals with pyro-electricity, pyro-magnetism, thermal dilatation, electrical and thermal conduction, thermo-electricity, dielectric influence, ferromagnetism, elasticity and internal friction, piezo-electricity and piezo-magnetism, and the effect upon them of change of temperature, all being considered specially with reference to crystals, as organised and perfect solids. The ground covered is thus very wide, and the practical investigator is most grateful to Prof. Voigt for placing within easy reach the theory and mathematics or all these branches of the subject. If only a few more practical hints as to the mode of carrying out the experiments, and more and better illustrations of the apparatus could have been given, the work would have been well-nigh perfect.

(2) This book does not profess to be a complete treatise on crystallography, but embodies the earlier lectures of the course in mineralogy given for some years by the author at the Ecole Nationale des Mines at Saint-Etienne, of which he is the director. Crystallography is considered first of all as the necessary introduction to the study of mineralogy by students training for mining engineers, and is therefore limited to those properties of crystals which are useful for the identification of mineral species. Hence, many of the less apparent physical properties of crystals are passed over, and those which are considered are dealt with from this limited point of view rather than for their own intrinsic interest. Indeed the author almost apologises for the necessity of treating even cursorily the fundamentally important optical properties of crystals.

The above will have sufficiently indicated the severe limitations of the book, and the narrow aspect from which it is presented. Crystallography has suffered, perhaps more than any other science, in the past from such limitations, imposed by being relegated to a corner in a course of mineralogy, which is itself frequently merely taken as a subsidiary part of a course in geology. There are strong indications that the time has now arrived, however, when these limitations should be swept away, and the fact boldly recognised

that the child has outgrown the parent, and that crystallography has become a wide and important subject on its own account, embracing (1) crystal morphology; (2) the optics and other physical properties of organised solids; (3) mineralogy; and (4) the crystallography of metals. Recent progress in the subject has been so rapid, its importance has become so palpably enhanced, that partial presentments of the character of the book before us are entirely behind the times, and no longer called for, except for the convenience of a particular set of students who may desire to have their professor's lectures before them in print.

While from the latter point of view it is possible to say much that is good about the book, there are some defects that cannot be ignored. The illustrations of crystals, for instance, are obviously in many cases inaccurately drawn, that is, not in clinographic or any other projection correctly to their proper elements, but are merely approximations of the nature of ruled rough sketches; hence, lines which should be parallel are often conspicuously not so. Also while one is glad to see a greater tendency than in other French books on this subject to employ the simple and scientific symbols of Miller for the crystal faces and forms, the advantages of which are fully admitted by the author, the notation of Levy is still given as well in conformity with French usage, although the probable confusion to the mind of the student would appear to dictate its abandonment as an unnecessary complication, especially considering the limited time available for the crystallographic part of the curriculum of these students.

A further limitation is the marked tendency to base the whole crystal morphology exclusively on the laws of Haüy as expanded by Mallard, and on the space-lattices of Bravais. Now it will be clear from the following review of Prof. Sommerfeldt's book how great is the importance of the space-lattice; but this book goes to the other extreme in stopping short at this work of the French savants. The only work on homogeneous structures referred to beyond it is that of Schönflies, and this, moreover, is only dealt with briefly as an afterthought in an appendix, and apparently largely as a development of the mathematical work of Jordan. No mention could be found of the work of Sohncke, von Fedorow, or Barlow, in developing the 230 types of homogeneous structures possible to crystals.

Curiously enough, the part of the book most diffidently presented, the optical, is the most readable and interesting, and is marked with originality of distinct value. Indeed, this section leaves the reader with the wish that it had been extended, as the author appears to be on specially familiar and congenial ground.

(3) This is a suggestive little book, the main object of which appears to be to present a simplification of the mode of regarding the homogeneous structure of crystals as a complicated point-system of the character indicated by Sohncke. Its essence is that the space-lattice (Raumgitter) is considered as the basis of the structure. The method is to drop the idea of essen-

tial parallelism, same-ways orientation, of the structural units, and to develop systematically in stages, starting from parallelism in the holohedral class of a crystal system, the possibilities of alternation and other forms of partial parallelism. The idea is justified from two points of view, first, that of the simplification for the student, who can readily construct the fourteen models of the Bravais space-lattices, by means of knitting needles and spherical balls impaled on them, and indicate on them if he chooses the stages of parallelism, corresponding to the various classes, by means of little inclined rods or other devices for indicating differences in the nature of the nodes of the space-lattice; and secondly, from the point of view of the undoubted importance of the space-lattice as regards crystal structure, and the fact that the space-lattice represents the arrangement of the molecules, while the Sohnckian points clustered around its nodes represent the arrangement of the atoms, and that models of such Sohnckian systems of points are very difficult to construct.

An excellent series of stereoscopic photographs of the fourteen space-lattices are given, forming quite a feature of the book, the photographs not merely representing the spherical balls on the steel rods but the shape in stereographic projection of the solid formed by the elementary cell or unit "brick" of the crystal edifice. The photographs were taken from models in the laboratory of Prof. von Groth at Munich. It is interesting to note also that the system of closest packing, as used by Pope and Barlow, is adopted in the book.

After a few pages of instruction in the elementary facts and nomenclature of crystallography, the author passes on to compare holohedral and partial symmetry, and shows how by placing a short inclined stroke, rod, or bar at each point of intersection or node of a space-lattice, and doing so either parallel-wise or in an alternately arranged manner, the idea of parallelism or otherwise, and even of a screw arrangement, may be indicated directly on the space-lattice itself, the disposition of the cluster of Sohnckian points about each node of the space-lattice being thus indicated by the mode of arranging the little stroke or rod. It is shown that such an arrangement fulfils Wiener's principle, that homogeneity consists in the continual repetition throughout space of the same relation between an elementary atom and the entire structure. The diagrams in the second part of the book indicate how this idea of constructing all the variations of class symmetry of a crystal-system on separate models of the same space-lattice can be carried out, and the book is well worth attention on account of the simplification which it thus presents of the admittedly most difficult part of crystallography. The difference between right- and left-handed mirror-image forms is also very clearly brought out.

While the particular mode of applying these ideas of Prof. Sommerfeldt is new, it can scarcely be said that the principle is. For Mr. Barlow long ago employed models of the human hand at the nodes of the space-lattice, or about them, to indicate orienta-

tional differences of the atomic cluster which each such node represents. But the present mode of differentiation employed by the professor of mineralogy of Tübingen has the especial merit of emphasising in an unmistakable manner the importance of the space-lattice as the fundamental basis of crystal structure.

A. E. H. T.

#### MODERN EXPLOSIVES.

*Les Explosifs modernes.* By Paul F. Chalon. Troisième édition. Pp. 787. (Paris: Librairie Ch. Béranger, 1911.) Price 25 francs.

THIS volume is really an encyclopædia on the subject of explosives, although many of the materials described, however interesting, are scarcely to be regarded as explosives, for it is only in very exceptional circumstances that they can behave as such or enter into the composition of explosive mixtures.

The book is divided into five parts, dealing respectively with (i.) explosive substances and the primary materials employed in the industry; (ii.) the manufacture of powders and explosives; (iii.) pyrotechny; (iv.) the methods of employing powders and explosives; (v.) employment of explosives for mining and various other applications; (vi.) legislation.

It would indeed be difficult to turn to the book for information on any substance which has either been employed or suggested for use as an explosive for any purpose, and the author has certainly carried out the descriptive part of the work in a thorough manner, the recent improvements in manufacture, for example, with guncotton and nitroglycerine at Waltham Abbey, being satisfactorily dealt with.

No doubt the author as a mining engineer feels the necessity of including much matter which is familiar to the chemist or manufacturer, such, for example, as the percentage composition of common salts, the different series of hydrocarbons, alcohols, &c., but it is to be regretted that chemical formulæ are so frequently incorrectly given that a lengthy errata, mainly to correct these chemical faults, is required, but even this fails to cover all the sins of commission.

Many interesting substances, unfamiliar even to those engaged in the industry, are briefly described, such as the remarkable crystalline explosive salts resulting from the electrolysis of solutions of antimony with an antimony anode, the sulphides and selenides of nitrogen, the sulphide of carbon  $C_3S_3$ , which compares with iodide of nitrogen in sensitiveness. In dealing with the explosive nature of compressed acetylene, the author states that its use has had to be abandoned in view of its explosive character, yet by the simple compression into steel cylinders containing porous blocks saturated with acetone, acetylene is now a valuable commercial product, and is largely employed in conjunction with oxygen for cutting steel plates, welding, and other purposes where a high temperature is demanded.

The author's connection with mining ensures that the application of various explosives for blasting purposes, submarine blasting for the removal of obstructions to navigation, including sunken vessels, is